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Germination Dynamics of *Crateva adansonii* D.C. and *Sarcocephalus latifolius* (Smith) Buce: Key Forest Trees of Burkina Faso

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Authors' contributions

This work was carried out in collaboration among all authors. Author SAK designed the study, wrote the protocol, and the first draft of the manuscript. Author NO collected and analysed the data and wrote the first draft. Authors JTY and ZS gave advice and managed the literature searches. Author HM gave advice and supervised the study. All authors read and approved the final manuscript.

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ABSTRACT

Crateva adansonii D.C. (Capparaceae) and *Sarcocephalus latifolius* (Smith) Buce (Rubiaceae) are two African tree species widely known as multipurpose species for rural populations. Unfortunately, these species are threatened in their natural stands by inappropriate management practices. In

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addition, their germination capacities are poor in their natural stands Our hypothesis is that the seeds of both species are capable of germination under certain conditions of temperature, light and germination medium. This work aims to study the germination capacity of these species under different conditions. Germination tests were carried out in the laboratory and in the field. 400 seeds of *C*. *adansonii* were used in five treatments and 960 seeds of *S. latifolius* in six treatments. Blotting papers and soil were used as media. Seeds were germinated under different temperature and light conditions over a period of 30 days. A seed was germinated when part of the embryo appeared. The maximum germination rate was obtained after 28 days for *C*. *adansonii* and 22 days for *S. latifolius*. The results show that the best germination rates of *C*. *adansonii* (85%) and *S. latifolius* (82%) are obtained when the seeds are exposed to white light for 12 hours, alternating with 12 hours of darkness. For generative propagation of these plants, it is recommended to germinate the seeds under optimal conditions and then to plant them instead of sowing them in the field.

Keywords: Seed multiplication; germination rate; germination test; germination kinetics; influence of light and temperature on germination.

1. INTRODUCTION

In Burkina Faso, certain widely used woody species are undergoing a rapid decline in their ecosystems as a result of uncontrolled exploitation and lack of domestication measures, partly linked to a lack of forest management control. This is the case of *Crateva adansonii* D.C. (Capparaceae) and *Sarcocephalus latifolius* (Smith) Buce (Rubiaceae), two woody plants that are widely used (Arbonier 2019) but threatened in different regions of their African range, such as Uganda (Tabuti et al. 2003), Togo (Attoh & Ahama, 2018) and Burkina Faso (Thiombiano et al., 2010). The leaves of *Crateva adansonii* are edible. *Sarcocephalus latifolius* is a medicinal plant used for various ailments such as malaria, diarrhoea and sore eyes (Kaboré et al., 2014). In particular, the use of its roots poses a threat to individuals of this species (Kaboré et al., 2015). *Crateva adansonii* treats high blood pressure and asthma (Todou et al., 2022). The aqueous extract of the bark of the species has a higher anti-urolithiasis activity on the formation of CaC2O4 crystals (Madawala et al. 2022). In Camerron, Todou et al. (2022) find that overexploitation and inappropriate management practices are the main threats to the species' populations.

Several species have difficulty establishing in certain environments. Several climatic factors such as humidity, temperature and light influence the germination and growth of their seedlings. This is the case for *Sarcocephalus latifolius* (Smith) Buce, which needs optimum temperature and light to germinate (Stangeland et al, 2007). The multiplication of *C. adansonii* is difficult because of poor seed germination (Tyagi et al. 2010). Our hypothesis is that the seeds of both species are capable of germination under certain conditions of temperature, light and germination medium. The aim of this study was to contribute to a better understanding of the regeneration capacity of local species, by determining the best conditions for seed germination.To do this, tests were conducted in the laboratory and in the field to determine the impact of light and temperature on the germination of the seeds of these two species.

2. MATERIALS AND METHODS

The laboratory germination test was carried out using eighty (80) Petrie dishes, one hundred and forty-four (144) blotting papers and soil. We sterilised tap water to moisten some of our tests. The Petri dishes and blotting papers were also sterilised before the tests. We used tweezers to place the tiny *S latifolius* seeds on the blotting papers and used a hand-held magnifying glass to observe the germination of these tiny seeds. We used 100% ethanol to disinfect our hands and tweezers before handling the seeds. We placed a thermometer in the different test conditions to observe the temperature. Before the experiments, we estimated the weight of the sheaths using a precision balance. To estimate the weight of a seed, one hundred seeds of each species were randomly selected and weighed. Thirty-two (32) days after the start of the experiment, 15 plants of each species were randomly selected and the length of their roots and stems was measured for the batch with the best germination rate.

2.1 Germination trial of *C. adansonii*

The *C. adansonii* seeds came from planted trees. The seeds were not subjected to any pre-

treatment. Five lots were formed and assigned to different conditions. The first four lots consisted of eight Petri dishes each. Ten seeds were placed in each dish. The fifth lot was a plot established in the field. In each Petri dish of lots 1, 3 and 4, three blotting papers were placed and the seeds were arranged in a circular pattern on the blotting papers, which had previously been moistened with sterilised tap water. For lot 4, the Petri dishes were placed in an incubation chamber for 12 hours under white light, alternating with 12 hours in the dark, at a temperature between 20 and 30°C. For lot 5, we prepared a small plot, 2.5 m long and 1 m wide, where the soil was loosened with a pickaxe; it is sandy in texture and contains gravel. Eighty seeds were sown 5 cm above the soil in the plot, with one seed per stake. A total of 400 seeds of *C. adansonii were* uses in this essay of germination (Table 1). Rain was the only source of water for the plot. The trial was established in September, the wettest month of Bobo-Dioulasso. The whole experiment was established on the same day.

2.2 Germination trial of *S. latifolius*

Sarcocephalus latifolius seeds were collected from ripe fruits harvested in the natural environment near the Bontioli Reserves (0°40' North and 2°53' West). They were stored for six months at a temperature between 25°C and 30°C. To extract the seeds, the dried fruits were broken, the seeds were collected and the impurities were removed by manual sorting. The seeds were not subjected to any pre-treatment. Six lots of eight Petri dishes each were prepared. For lots 1, 4, 5 and 6, three blotting papers were placed in each Petri dish. The Petri dishes for lots 2 and 3 were filled with soil. Each Petri dish contained twenty seeds arranged in a circular pattern and each lot was assigned to specific conditions. For lot 5, the Petri dishes were placed in an incubation room (Fig. 1) under UV (ultraviolet) light for 12 h, alternating with 12 h in the dark, at a temperature between 20 and 25°C. A total of 960 seeds of *S. latifolius* were uses in this experiment (Table 2). The system was set up on the same day. The blotting papers were moistened with sterilised tap water ; the soil lots were moistened with unsterilised tap water.

Germination was observed every two days for thirty days. We adopted the definition of germination given by Binet & Brunel (1968), who consider that germination corresponds to the appearance of part of the embryo outside the seed envelopes.

2.3 Data Analysis

Data were entered into Excel 2019. The number of germinated seeds was summed per day of observation and per treatment. This sum was accumulated as the observation progressed until the 30th day. The germination kinetics per treatment and per species were obtained by following the germination rate (Gr) over time, calculated by the following formula.

$$Gr = \frac{n}{N}100$$

where n= number of seeds germinated; N= total number of seeds.

Table 1. Experimental protocols for germination tests on *C. adansonii* seeds

Lots	Number of repetitions	Total seeds number	Germination medium	Seeding Technology	Temperature (°C)	Lighting
1	8	80	Blotting paper	Deposit on blotting paper	25-30	Daylight
2	8	80	Soil	Deposite on the soil	25-30	Daylight
3	8	80	Blotting paper	Deposit on blotting paper	30	Darkness 24h/24h
4	8	80	Blotting paper	Deposit on blotting paper	20-30	light 12 h / Darkness 12 h
5	8	80	Soil (Field)	Sowing 5 cm below the surface	Natural conditions	Natural conditions
Total	40	400				

Table 2. Experimental protocols for germination trial of *S. latifolius* seeds

Lots	Number of repetitions	Total seeds number	Germination medium	Seeding Technology	Temperature (°C)	Lighting
1	8	160	Blotting paper	Deposit on blotting paper	25-30	Daylight
2	8	160	Soil	Deposite on the soil	25-30	Daylight
3	8	160	Soil	Sowing under the soil	25-30	Daylight
4	8	160	Blotting paper	Deposit on blotting paper	30	Daylight
5	8	160	Blotting paper	Deposit on blotting paper	20-25	12 h ultra violet/12 h darkness
6	8	160	Blotting paper	Deposit on blotting paper	20-30	12 h white light /12 h darkness
Total	48	960				

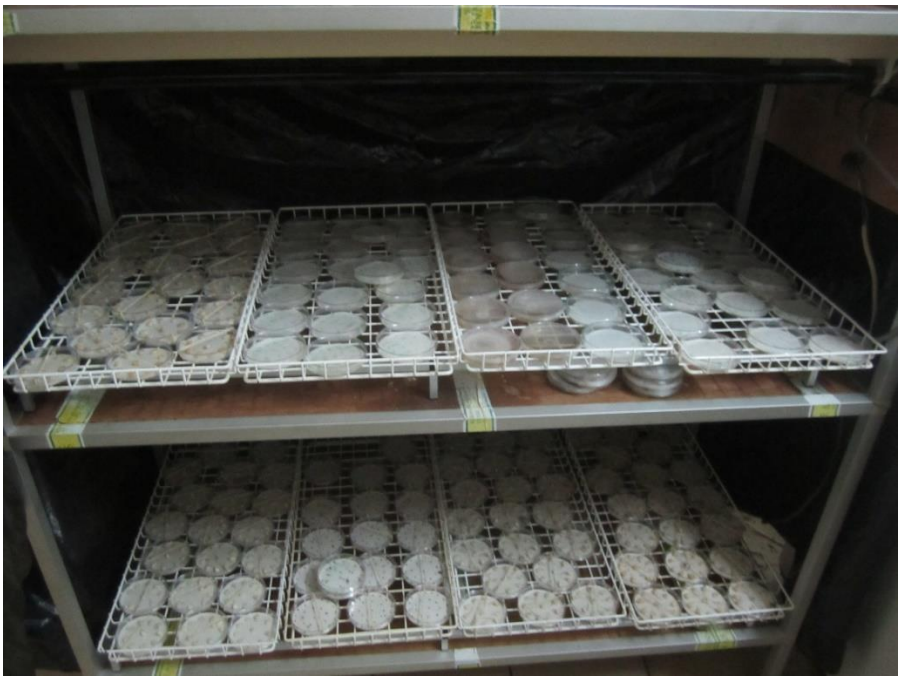

Fig. 1. Seeds placed in the incubation chamber.

3. RESULTS

The germination of *C. adansonii* and *S. latifolius* is hypogeous. The weight of 100 seeds of *C. adansonii* is 15.44 g, so the weight of one seed is 0.1544 g. Fig. 2 shows the germination kinetics of *C. adansonii*. The best germination rate (85%) was observed in lot No. 4, i.e. when the seeds were placed on blotting paper and subjected to alternating periods of 12 hours light and 12 hours dark at a temperature between 20 and 30°C. However, none of the seeds from lot 1 (blotting paper + 25-30°C + very variable light conditions) and lot 5 (sown in the field) germinated. The results also show that the seeds do not germinate in the dark (lots 2 and 5). Germination did not start until 8-12 days after sowing. The maximum germination rate was reached 28 days after sowing (Fig. 2). At 32 days after sowing, germinated seeds from lot 4 (Fig. 3) had the following characteristics: stem length 4.75±1.08 cm; root length 5.60±1.16 cm.

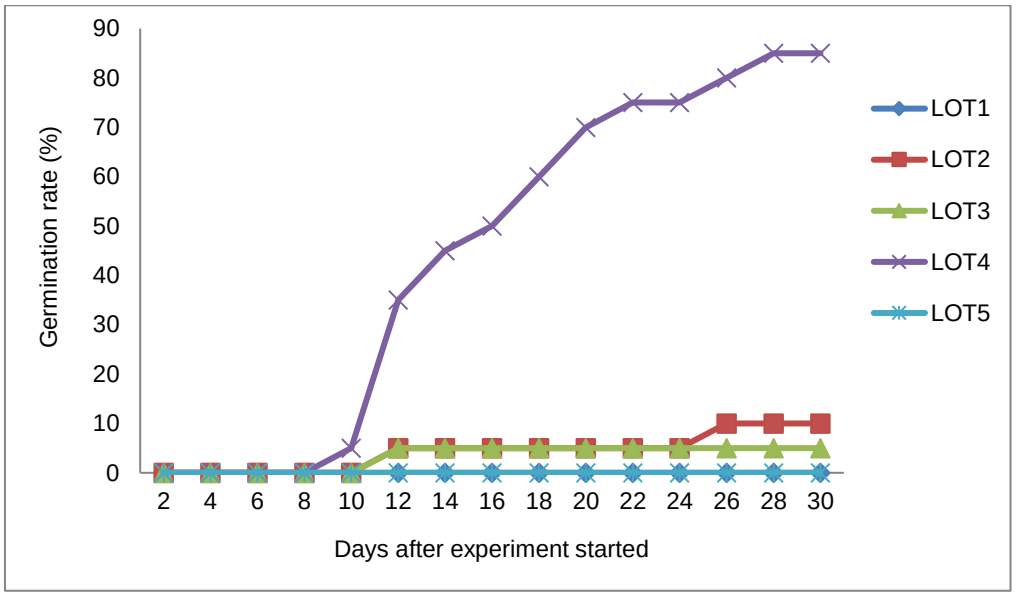

Fig. 2. Germination kinetics of *C. adansonii* as a function of treatment. Lot 1: blotting paper + 25-30°C+ highly variable light conditions; Lot 2: soil + 25-30°C+ highly variable light conditions; Lot 3: blotting paper + 30°C + total darkness; Lot 4: blotting paper + 20-30°C +12 h light and 12 h darkness; Lot 5: seeds sown in the field

Fig. 3. Seeds of *Crateva adansonii* 20 days after sowing of the lot 4 (blotting paper + 20-30°C +12 h light and 12 h darkness)

The weight of 100 seeds of *S. latifolius* is 0.022g, so the weight of one seed is 0.00022g. The results show that for *S. latifolius*, only the seeds in lot 3 (seeds placed in soil + 25-30°C + very variable light conditions) and lot 4 (blotting papers + 30°C + total darkness) did not germinate (Fig. 4). As with *C. adansonii*, the best germination rate for *S. latifolius* (82%) was observed in lot 6 (blotting paper + 20-30°C + alternating 12 h of white light and 12 h of darkness). In terms of kinetics, a delay of 8 to 10 days was observed before the first germinations. The maximum germination rate was reached at 22 days (lots 6 and 2) (Fig. 5). At 32 days after sowing, the germinated seeds of lot 6 had the following characteristics: stem length 0.85±0.45 cm ; radicle length 0.85±0.40 cm.

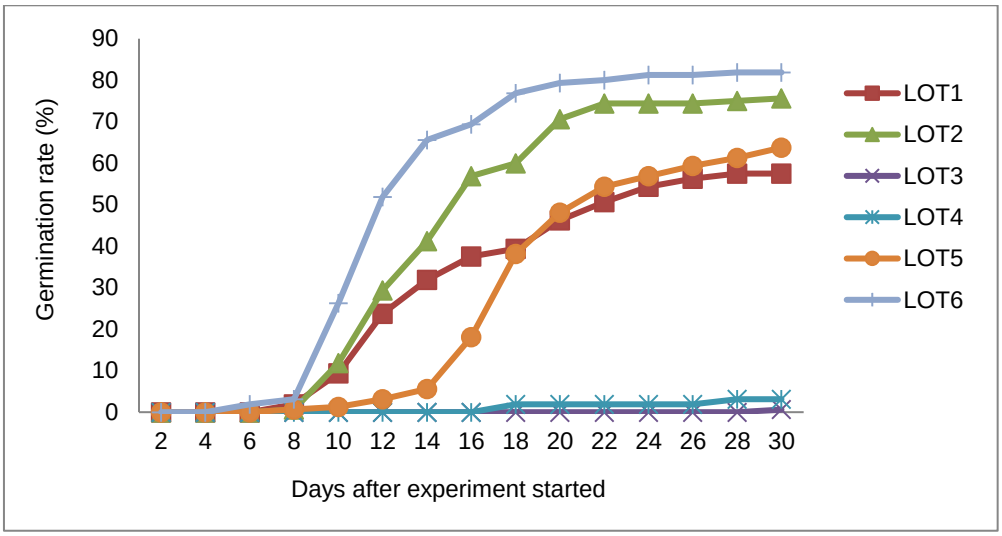

Fig. 4. Germination kinetics of *Sarcocephalus latifolius* as a function of treatment. Lot 1: blotting papers + 25-30°C+ highly variable light conditions; Lot 2: seeds placed on soil + 25-30°C+ highly variable light conditions; Lot 3: seeds placed underground + 25-30°C+ highly variable light conditions; Lot 4: blotting papers + 30°C+ total darkness; Lot 5: blotting papers + 20 and 25°C.+ alternating 12 h ultra violet light and 12 h darkness; Lot 6: blotting papers + 20-30°C + alternating 12 h white light and 12 h darkness.

Fig. 5. Seeds of *Sarcocephalus latifolius* 20 days after sowing of the lot 6 (blotting papers + 20-30°C + alternating 12 h white light and 12 h darkness)

4. DISCUSSION

The different treatments to which the seeds of the two species were subjected revealed the germination behaviour of the seeds as a function of light, temperature and germination medium. The results show that temperatures between 20 and 30°C and light of at least 12 hours per day favour the germination of seeds of both species. The work shows that *C. adansonii* germinates poorly under natural conditions, as also reported by Attoh & Ahama (2018). However, shelling of these seeds facilitates germination, which can reach 100% (Attoh & Ahama 2018). The seed coat therefore limits the plant's seed regeneration. Fortunately, the plant reproduces by suckering. However, suckering limits the spread of *C. adansonii* over large areas (Tyagi et al, 2010). Sharma et al. (2003) suggest propagation by grafting axillary buds onto rootstocks.

Stangeland et al. (2007) also show that the best germination rates for *S. latifolius* are obtained at temperatures between 20 and 35°C and that the species needs light to germinate. The best germination rate of *S. latifolius* obtained by these authors is 60%, which is significantly lower than the best germination rate found in this study (82%). This difference of more than 20% between the two results could be explained by the fact that the individuals of *S latifolius* from Uganda and Burkina Faso belong to different ecotypes.

In the studies by Stangeland et al. (2007), no *S. latifolius* seeds germinated in the natural environment (savannah conditions), whereas in our laboratory trials we observed a good germination rate in the lot containing soil from the natural environment (lot no. 2). This shows that environmental factors other than the condition of the soil inhibit germination. A good germination aid could improve the germination rate of *S. latifolius* in the natural environment.

By comparing the germination kinetics of the two species, we find that the germination time of *S. latifolius* is shorter than that of *C. adansonii*. Seed germination kinetics have received less attention, so there are no unified models to describe the rate and kinetics of seed germination (Zhou et al. 2019). Germination rates differ between the two species. The morphology and physiology of the seeds of these two species may explain this difference. Although the seed sizes of the two species are different, they have the same type of germination. Our results show that germination of both species is inhibited by total darkness, even when the temperature is optimal for germination. The results of Stangeland et al. (2007) also show a very low germination rate for the *S. latifolius* species under conditions of total darkness. Light and temperature seem to be two complementary factors necessary for germination of *C. adansonii* and *S. latifolius*.

4. CONCLUSION

The aim of this study was to characterise the germination capacity of *C. adansonii* and *S. latifolius*. A temperature between 20 and 30°C and alternating 12 h of light and 12 h of darkness are the optimal conditions for germination of the two species studied. Temperature and germination medium acted as complementary factors influencing the germination of these species. Based on the most optimistic future climate scenarios, which predict an increase in temperature, seeds with positive photosensitivity that require a certain temperature range will have more difficulty in germinating properly. It is strongly recommended that these seeds are germinated under optimal conditions (12 hours of white light alternating with 12 hours of darkness and a temperature between 20°C and 30°C) and then planted rather than sown in the field. Future work should test the resistance of seedlings of the two species to abiotic stresses such as water stress and temperature extremes on plant growth and vigour.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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